Air Pollution Technology Fact Sheet

1. ***Name of Technology:*** Elutriators

This type of technology is a part of the group of air pollution controls collectively referred to as "precleaners," because they are oftentimes used to reduce the inlet loading of particulate matter (PM) to downstream collection devices by removing larger, abrasive particles. Elutriators are mainly used in non-pollution control processes to separate particle sizes.

2. ***Type of Technology:*** Removal of PM by gravitational settling.

3. ***Applicable Pollutants:***

Elutriators are used to control larger sized PM, primarily PM greater than 10 micrometers (μm) (PM_{10}) in aerodynamic diameter.

4. ***Achievable Emission Limits/Reductions:***

The control efficiency of elutriators is similar to that of settling chambers, the difference being that elutriators are designed to remove PM greater than a specified particular size. The collection efficiency of an elutriator varies as a function of particle size and elutriator design. Elutriator efficiency generally <u>increases</u> with (1) particle size and/or density, (2) decrease in flow velocity, and (3) number of vertical tubes or towers. Gravitational force may be employed to remove particles where the settling velocity is greater than about 13 centimeters per second (cm/s) (25 feet per minute (ft/min)). In general, this applies to particles larger than 50 μm if the particle density is low, down to 10 μm if the particle density is reasonably dense. Particles smaller than 10 μm require excessive vertical flow distances, which lead to excessive device height. Collection efficiency for PM_{10} is very low, typically less than 10 percent (Wark, 1981; EPA, 1998).

5. ***Applicable Source Type:*** Point

6. ***Typical Industrial Applications:***

Elutriators are generally designed for specific applications. They are not adequate to meet stringent air pollution regulations, but serve an important purpose for size classification of PM for disposal or reintroduction into a process. Elutriators are typically used to separate larger particles from smaller particles which remain in the waste gas. They are often followed by another mechanical collector (e.g., a cyclone) which removes the smaller PM. Typical uses of elutriators are in granulated plastics processes, secondary metal operations, food and agricultural processes, and petrochemical industries. Elutriators generally treat flows of smaller volume than most other mechanical collectors (e.g., cyclones, settling chambers, momentum separators), and are generally considered as a process control rather than air pollution control equipment (EPA, 1982; Parsons, 1999).

7. *Emission Stream Characteristics:*

a. ***Air Flow:*** Typical gas flow rates for an elutriator unit are 0.25 to 4 standard cubic meters per second (sm^3/sec) (530 to 8,500 standard cubic feet per minute (scfm)) (Parsons, 1999; Steinbach, 1999).

b. ***Temperature:*** Inlet gas temperatures are only limited by the materials of construction of the elutriator, and have been operated at temperatures as high as 540°C (1000°F) (Wark, 1981; Perry, 1984).

c. ***Pollutant Loading:*** Waste gas pollutant loadings can range from 20 to 4,500 grams per standard cubic meter (g/sm^3) (9 to 1,970 grains per standard cubic foot (gr/scf)) (Parsons, 1999; Steinbach, 1999).

d. ***Other Considerations:*** Leakage of cold air into an elutriator can cause local gas quenching and condensation. Condensation can cause corrosion, dust buildup, and plugging of the hopper or dust removal system. The use of thermal insulation can reduce heat loss and prevent condensation by maintaining the internal device temperature of the above the dew point (EPA, 1982).

8. *Emission Stream Pretreatment Requirements:*

No pretreatment is necessary for elutriators.

9. *Cost Information:*

The following are cost ranges (expressed in third quarter 1995 dollars) for an elutriator under typical operating conditions, developed using manufacturer information and a modified EPA cost-estimating spreadsheet (EPA, 1996) and referenced to the volumetric flow rate of the waste stream treated. For purposes of calculating the example cost effectiveness, flow rates are assumed to be between 0.25 to 4 sm^3/sec (530 to 8,500), the PM inlet loading concentration is assumed to range from approximately 20 to 4,500 g/sm^3 (9 to 1,970 gr/scf) and the control efficiency is assumed to be 50 percent. The costs do not include costs for disposal or transport of collected material. Capital costs can be higher than in the ranges shown for applications which require expensive materials. As a rule, smaller units controlling a low concentration waste stream will be more expensive (per unit volumetric flow rate) than a large unit cleaning a high pollutant load flow.

a. ***Capital Cost:*** \$10,500 to \$17,800 per sm^3/sec (\$4.90 to \$8.40 per scfm)

b. ***O & M Cost:*** \$1,700 to \$3,400 per sm^3/sec (\$0.80 to \$1.60 per scfm), annually

c. ***Annualized Cost:*** \$2,500 to \$4,800 per sm^3/sec (\$1.20 to \$2.30 per scfm), annually *d.* ***Cost Effectiveness:*** $0.12 to $14 per metric ton ($0.11 to $13 per short ton), annualized cost per ton per year of pollutant controlled

10. Theory of Operation:

An elutriator is essentially a vertical settling chamber. Elutriators consist of one or more vertical tubes or towers in series into which a dust-laden gas stream passes upward at a velocity defined by the gas flow rate and the tube cross-sectional area. Large particles with terminal settling velocities greater than the upward gas velocity are separated and collected at the bottom of the chamber. Smaller particles with lower settling velocity are carried out of the collector. The particle size collected may be varied by changing the gas velocities. Size classification of the collected particles can be achieved by using a series of tubes with increasing diameters. Hoppers are generally used to collect the settled-out material. The dust removal system must be sealed to prevent air from leaking into the chamber which increases turbulence, causes dust reentrainment, and prevents dust from being properly discharged from the device (EPA,1982; EPA, 1998).

11. Advantages/Pros:

Elutriators share many of the advantages of other mechanical collectors (Wark, 1981; Corbitt, 1990; Perry, 1984; and EPA, 1998):

1. Low capital cost;
2. Low energy cost;
3. No moving parts, therefore, few maintenance requirements and low operating costs;
4. Excellent reliability;
5. Low pressure drop across device;
6. Device not subject to abrasion due to low gas velocity;
7. Provide incidental cooling of gas stream;
8. Temperature and pressure limitations are only dependent on the materials of construction; and,
9. Dry collection and disposal.

12. Disadvantages/Cons:

Elutriators also share the disadvantages of mechanical collectors (Wark, 1981; and EPA, 1998):

1. Relatively low PM collection efficiencies;
2. Unsuitable for sticky or tacky materials; and
3. Large physical size.

13. Other Considerations:

The most common failure mode of elutriators is plugging of the device with collected dust. Plugging can result from hopper bridging or hopper discharge seal failure. Such failures can be prevented or minimized by use of hopper level indicators or by continuous monitoring of the dust discharge. Scheduled internal inspection can determine areas of air leakage and condensation, both of which may cause hopper bridging. Normal instrumentation for an elutriator generally includes only an indicator of differential static pressure. An increase in static pressure drop can indicate plugging (EPA, 1982).

14. References:

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EPA, 1982. U.S. EPA, Office of Air Quality Planning and Standards, "Control Techniques for Particulate Emissions from Stationary Sources - Volume 1," EPA-450/3-81-005a, Research Triangle Park, NC, September.

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Wark, 1981. Kenneth Wark and Cecil Warner, "Air Pollution: Its Origin and Control," HarperCollins, New York, NY, 1981.